Optical mechanism driving device

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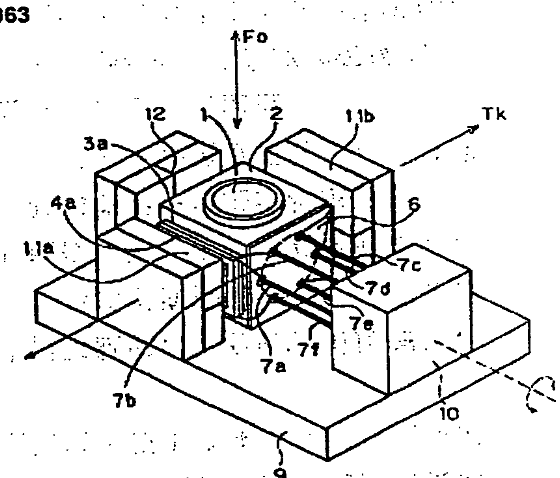
An objective lens (1) for focusing light on an optical recording medium (not shown) and irradiating the same with the focused light is held on a lens holder (2). A support member (10) is provided on a base member (9) as a foundation of a device for driving optical system. The lens holder (2) is supported on the support member (10). Six linear elastic bodies (7a through 7f) of the same length are cylindrically shaped. The lens holder (2) is supported on the support member (10) by the linear elastic bodies (7a through 7f). A center of a circle formed by the ends of the linear elastic bodies (7a through 7f) is an axis of point symmetry thereof. Distances between adjacent ones of the ends of the linear elastic bodies (7a through 7f) are all the same.



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BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to a device for driving optical system for writing or reading information to and from an optical recording medium such as DVD. More particularly, it relates to a supporting mechanism and a driving mechanism for the optical system.

[0003] 2. Description of the Background Art

[0004] A well-known device for driving optical system is introduced in Japanese Patent Application Laid-Open No. 2001-297460. FIG. 17 is a perspective view illustrating a background-art device for driving optical system disclosed therein. The device given in FIG. 17 is a driving device for optical system in which an objective lens 101 is controlled by moving coil system. The objective lens 101 is fixed to a lens holder 102. Provided on the side surfaces of the lens holder 102 are six strip metal plates 103a through 103c, and 103d through 103f. Print coils 104a and 104b are fixed to other side surfaces of the lens holder 102. A base member 105 has a suspension holder 106 for supporting the lens holder 102, and permanent magnets 107a through 107d for controlling the lens holder 102. The strip metal plates 103a through 103c and 103d through 103f are connected to the suspension holder 106 by suspension wires (linear elastic bodies) 108a through 108c and 108d through 108f, respectively, to support the lens holder 102 on the base 105 member. The print coil 104a is interposed between the permanent magnets 107a and 107b, and the print coil 104b is interposed between the permanent magnets 107c and 107d.

[0005] Next, the operations of the background-art device will be discussed. When a current is supplied to focusing coils embedded in the print coils 104a and 104b (not shown) so as to generate electromagnetic forces to act on the coils in the same direction, the lens holder 102 is displaced in the direction Fo of an optical axis (hereinafter alternatively referred to as focusing direction). Further, when a current is supplied to tracking coils embedded in the print coils 104a and 104b (not shown) so as to generate electromagnetic forces to act on the coils in the same direction, the lens holder 102 is displaced in a tracking direction Tk that is a radial direction of an optical recording medium. Still further, when a current is supplied to the focusing coils (not shown) so as to generate electromagnetic forces to act on the coils with the opposite directions, rotation moment about the tracking direction Tk as an axis thereof is applied to the lens holder 102. As a result, the lens holder 102 is rotated in a tilting direction Ti. FIG. 18 is a sectional view illustrating how the lens holder is rotated in the tilting direction Ti. If the electromagnetic forces are generated to act on the focusing coils (not shown) in the opposite directions, the strip metal plates 103a and 103c are displaced and distorted towards the opposite directions by the same amount. As a result, a center of the strip metal plate 103b will be a center 0 of rotation in the tilting direction Ti, thus rotating the lens holder 102 to an angle 0 and displacing the same in the tilting direction Ti. Triaxial drive, namely, drive in the focusing direction Fo, tracking direction Tk, and in the tilting direction Ti, is thereby allowed.

[0006] For realizing triaxial drive, the background-art device requires two electric wires for supplying current to the focusing coil in the print coil 104a, two electric wires for supplying current to the focusing coil in the print coil 104b, and two electric wires for supplying current to

the tracking coils in the print coils 104a and 104b, respectively. Namely, a total of six electric wires are required. For this reason, the six suspension wires 108a through 108f for supporting the lens holder 102 are also used as electric wires for current supply in the background-art device.

[0007] In the background-art device for driving optical system, however, the suspension wires 108a through 108f should contact the strip metal plates 103a through 103f on the side of the lens holder 102. Therefore, the background-art device necessarily requires six strip metal plates, leading to the increase in number of parts. As a result, the problems involving rise in cost of the parts and increase in number of assembly steps have been unavoidable. In the background-art device, further, the suspension wires 108a through 108f and the strip metal plates 103a through 103f should be respectively connected. Therefore, variations of the parts may occur in the assembled condition, resulting in unevenness in performance of the devices.

SUMMARY OF THE INVENTION

[0008] It is therefore an object of the present invention to provide a device for driving optical system only requiring at least six suspension wires (linear elastic bodies) for supporting a lens holder while allowing triaxial drive, namely, drive in a focusing direction, in a tracking direction, and in a tilting direction.

[0009] The device for driving optical system includes an optical system, a holder, a support member, a support system, a focusing drive system, a tracking drive system, and a tilting drive system. The optical system focuses light on an optical recording medium and irradiating the optical recording medium with focused light. The holder holds the optical system. The support member supports the holder. The support system includes at least six linear elastic bodies having the same length. The linear elastic bodies respectively have one ends fixed to the support member and arranged thereon approximately in a circle, and other ends fixed to the holder and arranged thereon approximately in a circle, to support the holder on the support member. The focusing drive system drives the holder in a direction of an optical axis of the optical system. The tracking drive system drives the holder in a radial direction of the optical recording medium. The tilting drive system drives the holder in a direction in which rotation moment generates about an axis. This axis is perpendicular to the direction of the optical axis and to the radial direction of the optical recording medium.

[0010] One ends of the at least six linear elastic bodies are fixed to the support member and arranged approximately in a circle thereon, and other ends of the six linear elastic bodies are fixed to the holder and arranged approximately in a circle thereon. The holder is thereby supported on the support member. Therefore, while allowing triaxial drive, cost reduction of parts is realized and the number of assembly steps is reduced. Further, variations of the parts can be reduced in the assembled condition, thus reducing the degree of unevenness in performance of the devices.

[0011] These and other objects, features, aspects and advantages of the present invention will become more apparent from the following detailed description of the present invention when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] FIG. 1 is a perspective view illustrating a device for driving optical system according to a first preferred embodiment of the present invention;

[0013] FIGS. 2 and 3 are perspective views each illustrating a lens holder of the device according to the first preferred embodiment of the present invention;

[0014] FIG. 4 is a plan view illustrating a movable side substrate according to the first preferred embodiment of the present invention;

[0015] FIG. 5 is a plan view illustrating a fixed side substrate according to the first preferred embodiment of the present invention;

[0016] FIGS. 6A and 6B are conceptual views each illustrating movement of movable side terminals caused by tilting control according to the first preferred embodiment of the present invention;

[0017] FIG. 7 is a perspective view illustrating a device for driving optical system according to a second preferred embodiment of the present invention;

[0018] FIGS. 8 and 9 are perspective views each illustrating a lens holder of the device according to the second preferred embodiment of the present invention;

[0019] FIG. 10 is a plan view illustrating a movable side substrate according to the second preferred embodiment of the present invention;

[0020] FIG. 11 is a plan view illustrating a fixed side substrate according to the second preferred embodiment of the present invention;

[0021] FIG. 12 is a perspective view illustrating a device for driving optical system according to a third preferred embodiment of the present invention;

[0022] FIGS. 13 and 14 are perspective views each illustrating a lens holder of the device according to the third preferred embodiment of the present invention;

[0023] FIG. 15 is a plan view illustrating a movable side substrate according to the third preferred embodiment of the present invention;

[0024] FIG. 16 is a plan view illustrating a fixed side substrate according to the third preferred embodiment of the present invention;

[0025] FIG. 17 is a perspective view illustrating a background-art device for driving optical system; and

[0026] FIG. 18 is a sectional view illustrating movement of a lens holder caused by tilting control in the background-art device for driving optical system.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0027] <First Preferred Embodiment>

[0028] FIG. 1 is a perspective view illustrating a device for driving optical system according to the first preferred embodiment of the present invention. Only a lens holder of the device is illustrated in each perspective view of FIGS. 2 and 3. An objective lens 1 for focusing light on an optical recording medium (not shown) and irradiating the same with the focused light is held on a lens holder 2. The lens holder 2 has a focusing coil 3, a tilting coil 4, and a tracking coil 5 provided on three surfaces thereof adjacent to the surface for holding the objective lens 1. The focusing coil 3 includes two coils 3a and 3b as illustrated in FIG. 4 provided in parallel on the surfaces of the lens holder 2. The coils 3a and 3b have the same winding direction. The tilting coil 4 includes two coils 4a and 4b provided in parallel, overlying the coils 3a and 3b,

respectively. The coils 4a and 4b have different winding directions. The tracking coil 5 is provided on the remaining surface of the foregoing three surfaces. Further, the lens holder 2 has a movable side substrate 6 on the surface thereof opposite to that for holding the tracking coil 5.

[0029] FIG. 4 is a plan view illustrating the movable side substrate. Six movable side terminals 8a through 8f are provided on the movable side substrate 6 for fixing the ends of six linear elastic bodies 7a through 7f, respectively. These movable side terminals 8a through 8f are arranged in a circle. A center of this circle is an axis of point symmetry of the movable side terminals 8a through 8f. Further, distances between adjacent ones of the movable side terminals 8a through 8f are all the same on the movable side substrate 6. For example, the distance between the movable side terminals 8a and 8b is the same as the distance between the terminals 8b and 8c.

[0030] A support member 10 is provided on a base member 9 as a foundation of the device for driving optical system. The base member 9 and the support member 10 serve as a support for the lens holder 2, which will be applied to the preferred embodiments to be described later. A permanent magnet 11 for focusing and tilting control, and a permanent magnet 12 for tracking control are provided on the base member 9. The permanent magnet 11 includes two permanent magnets 11a and 11b facing each other on the base member 9. The permanent magnets 11a and 11b for focusing and tilting control are each vertically polarized. The permanent magnet 12 is arranged on the base member 9 to face the support member 10. The permanent magnet 12 is horizontally polarized. The base member 9 generally includes metal such as magnetic material. Further, a fixed side substrate 13 is provided on the surface of the support member 10 for supporting the lens holder 2.

[0031] FIG. 5 is a plan view illustrating the fixed side substrate. Six fixed side terminals 14a through 14f are provided on the fixed side substrate 13 for further fixing the ends of the six linear elastic bodies 7a through 7f, respectively. These fixed side terminals 14a through 14f are also arranged in a circle. A center of this circle is an axis of point symmetry of the fixed side terminals 14a through 14f. Distances between adjacent ones of the fixed side terminals 14a through 14f are all the same on the fixed side substrate 13. The movable side terminals 8a through 8f and the fixed side terminals 14a through 14f are symmetrically arranged in mirror image, respectively. Further, the circle formed by the movable side terminals 8a through 8f and that formed by the fixed side terminals 14a through 14f are approximately the same in size.

[0032] In the device for driving optical system according to the first preferred embodiment, the lens holder 2 is so arranged to be surrounded by the support member 10, by the permanent magnets 11a and 11b each for focusing and tilting control, and by the permanent magnet 12 for tracking control, and to be supported on the support member 10 by the six linear elastic bodies 7a through 7f of the same length. The focusing coil 3 and the tilting coil 4 each face the permanent magnets 11a and 11b. The tracking coil 5 faces the permanent magnet 12.

[0033] The linear elastic bodies 7a through 7f respectively connect the movable side terminals 8a through 8f and the fixed side terminals 14a through 14f. The linear elastic bodies 7a through 7f are formed of the same material. The ends of the linear elastic bodies 7a through 7f are arranged in the same manner as those of the movable side terminals 8a through 8f and the fixed side terminals 14a through 14f, namely, they are arranged in a circle. A center of the circle formed by the ends of the linear elastic bodies 7a through 7f is an axis of point symmetry

thereof. Further, distances between adjacent ones of the ends of the linear elastic bodies 7a through 7f are all the same. As seen from FIGS. 2 and 3, the linear elastic bodies 7a through 7f are thereby cylindrically shaped in the device of the first preferred embodiment. In addition to the operation for supporting the lens holder 2 on the support member 10, the linear elastic bodies 7a through 7f are also operable to supply current to the focusing coil 3, to the tilting coil 4, and to the tracking coil 5. The movable side terminals 8a through 8f are therefore connected to the focusing coil 3, to the tilting coil 4, and to the tracking coil 5 by electric wires.

[0034] Next, the operations of the device for driving optical system according to the first preferred embodiment will be discussed. In FIG. 1, a direction of an optical axis in which light is focused on an optical recording medium (not shown) for irradiating the medium with the focused light is referred to as a focusing direction Fo (vertical direction), and a radial direction of the optical recording medium is referred to as a tracking direction Tk (horizontal direction). Further, defining a direction perpendicular to the focusing direction Fo and to the tracking direction Tk as an axis, a direction in which rotation moment generates about this axis is referred to as a tilting direction Ti.

[0035] The device for driving optical system of the first preferred embodiment is controlled by moving coil system. That is, by supplying current to each coil attached to the lens holder 2, magnetic force is generated between each coil and each permanent magnet provided on the base member9. The magnetic force thus generated is used to control the position of the lens holder 2. The objective lens 1 is operable to focus light on the optical recording medium (not shown). On the other hand, focal point shift occurs by vertical movement of the optical recording medium such as wobble of the surface thereof. As a countermeasure therefor, in the device for driving optical system of the first preferred embodiment, a focusing sensor (not shown) is provided which is directed for well-known astigmatic compensation, for example. This focusing sensor detects the focal point shift, and applies a signal based on the amount of the focal point shift to the focusing coil 3. As a result, the lens holder 2 is displaced in the focusing direction Fo, by which focusing control is realized.

[0036] For reading information represented by bit sequence on the optical recording medium (not shown), the objective lens 1 is also operable to irradiate this bit sequence with the focused light. On the other hand, the objective lens 1 may cause track shift by eccentricity of the optical recording medium, for example. As a countermeasure therefor, in the device of the first preferred embodiment, a tracking sensor (not shown) is provided which is directed for well-known differential push-pull, for example. This tracking sensor detects the track shift, and applies a signal based on the amount of the track shift to the tracking coil 5. As a result, the lens holder 2 is displaced in the tracking direction Tk, by which tracking control is realized. During focusing control and tracking control as described, the linear elastic bodies 7a through 7f are cooperatively distorted toward the same direction. As a result, the objective lens 1 can be displaced by the desirable amount.

[0037] Due to the distortion of the optical recording medium (not shown) and wobble of the surface of the same resulting from rotative movement, the objective lens 1 may be tilted in the tilting direction Ti relative to the surface of the optical recording medium. Such tilt in the tilting direction Ti results in optical aberration and eventually, results in deterioration of a reproduced recording signal. As a countermeasure therefor, in the device of the first preferred embodiment, a well-known sensor system (not shown) is provided. This sensor system detects the amount

of the tilt, and applies a signal based on this amount to the tilting coil 4. As a result, the lens holder 2 is rotated in the tilting direction Ti, by which tilting control is realized. In the device of the first preferred embodiment, the lens holder 2 is supported on the support member 10 by the linear elastic bodies 7a through 7f of cylindrical configuration. Therefore, when the lens holder 2 is rotated in the tilting direction Ti by tilting control relative to the support member 10, the movable side terminals 8a through 8f merely move to the positions respectively relative to those of the fixed side terminals 14a through 14f. Further, the linear elastic bodies 7a through 7f all have the same length. Therefore, in the device of the first preferred embodiment, bending stress is not caused in the longitudinal direction of the linear elastic body 7. A force is generated only in the tilting direction Ti. As a result, the device of the first preferred embodiment does not require six strip metal plates. The lens holder 2 can be supported only by the six linear elastic bodies 7a through 7f, namely, by the reduced number of parts. Further, the lens holder 2 can be tilted in the tilting direction Ti by a desirable angle.

[0038] In the device for driving optical system of the first preferred embodiment, the ends of the linear elastic bodies 7a through 7f are shown to have an axis of symmetry thereof. However, such axis is not essential. Namely, even when the ends of the linear elastic bodies 7a through 7f have no axis of point symmetry, the elastic bodies 7a through 7f are still cylindrically shaped, thereby rotating the lens holder 2 in the tilting direction by a desirable angle. When the ends of the linear elastic bodies 7a through 7f have an axis of point symmetry as in the first preferred embodiment, the elastic bodies 7a through 7f only receive a couple of forces acting thereon as a resultant force of a reaction force generated by tilting control. In contrast, when these ends have no axis of point symmetry, the elastic bodies 7a through 7f receive a translational force acting thereon in addition to the couple of forces as a resultant force of the reaction force generated by tilting control. In view of this, the linear elastic bodies 7a through 7f should preferably have an axis of symmetry thereof, to reduce the amount of interference in focusing control and tracking control to be caused by tilting control.

[0039] FIG. 6 is a conceptual view illustrating movement of the movable side terminals 8a through 8f caused by tilting control. Positions of the movable side terminals 8a through 8f before tilting control are represented by white circles 15, and positions of those after tilting control are represented by black circles 16. After subjection to tilting control, the movable side terminals 8a through 8f each receive a reaction force 17 acting thereon. When the ends of the elastic bodies 7a through 7f have no axis of point symmetry, a resultant force of the reaction forces 17 is a couple of forces 18 and a translational force 19 as seen from FIG. 6A. When these ends have an axis of point symmetry, on the other hand, only the couple of forces 18 is generated as a resultant force of the reaction forces 17 as seen from FIG. 6B. Accordingly, when the ends of the elastic bodies 7a through 7f have no axis of point symmetry, the translational force 19 generated by tilting control will interfere in focusing and tracking control. In contrast, when these ends have an axis of point symmetry, there is no translational force 19 to be generated by tilting control, thus causing no interference in focusing and tracking control.

[0040] In the device for driving optical system of the first preferred embodiment, further, all the distances between adjacent ones of the linear elastic bodies 7a through 7f are shown to be the same. However, such uniformity in distance is not essential. Namely, even when the ends of the elastic bodies 7a through 7f have nonuniformity in distance therebetween, the elastic bodies 7a through 7f are still cylindrically shaped. The lens holder 2 is thereby rotated in the

tilting direction by a desirable angle. When the distances between adjacent ones of the elastic bodies 7a through 7f are all the same as in the first preferred embodiment, there occurs no asymmetry of reaction forces, leading to stable control for driving operations. As a result, the ends of the linear elastic bodies 7a through 7f should preferably have uniformity in distance therebetween.

[0041] In the first preferred embodiment, the lens holder 2 is supported on the support member 10 by the six linear elastic bodies 7a through 7f. However, the number of the linear elastic body may not be limited to this. As long as the linear elastic body is arranged in the same manner as that in the first preferred embodiment, the same effect can be obtained.

[0042] <Second Preferred Embodiment>

[0043] FIG. 7 is a perspective view illustrating a device for driving optical system according to the second preferred embodiment of the present invention. Only a lens holder of the device is illustrated in each perspective view of FIGS. 8 and 9. The structure of the lens holder 2 is the same as that in the first preferred embodiment. The objective lens 1 for focusing light on an optical recording medium (not shown) and irradiating the same with the focused light is held on the lens holder 2. The lens holder has the focusing coil 3, the tilting coil 4, and the tracking coil 5 provided on three surfaces thereof adjacent to the surface for holding the objective lens 1. Further, the lens holder 2 has the movable side substrate 6 provided on the surface thereof opposite to that for holding the tracking coil 5.

[0044] FIG. 10 is a plan view illustrating the movable side substrate. The six movable side terminals 8a through 8f are provided on the movable side substrate 6 for fixing the ends of the six linear elastic bodies 7a through 7f, respectively. These movable side terminals 8a through 8f are arranged in a circle. A center of this circle is an axis of point symmetry of the movable side terminals 8a through 8f. Further, distances between adjacent ones of the movable side terminals 8a through 8f are all the same on the movable side substrate 6.

[0045] The structure of the base member 9 as a foundation of the device is the same as that in the first preferred embodiment. More particularly, the base member 9 holds the support member 10 provided thereon for supporting the lens holder 2. Further provided on the base member 9 are the permanent magnet 11 for focusing and tilting control, and the permanent magnet 12 for tracking control. Further, the fixed side substrate 13 is provided on the surface of the support member 10 for supporting the lens holder 2.

[0046] FIG. 11 is a plan view illustrating the fixed side substrate. The six fixed side terminals 14a through 14f are provided on the fixed side substrate 13 for further fixing the ends of the six linear elastic bodies 7a through 7f, respectively. These fixed side terminals 14a through 14f are also arranged in a circle. A center of this circle is an axis of point symmetry of the fixed side terminals 14a through 14f. Distances between adjacent ones of the fixed side terminals 14a through 14f are all the same on the fixed side substrate 13. Contrary to the first preferred embodiment, the circle formed by the fixed side terminals 14a through 14f is smaller in size than the circle formed by the movable side terminals 8a through 8f.

[0047] Similar to the first preferred embodiment, the movable side substrate 6 and the fixed side substrate 13 are also connected by the six linear elastic bodies 7a through 7f having the same length, to support the lens holder 2 on the support member 10. The ends of the linear elastic bodies 7a through 7f are arranged in the same manner as those of the movable side terminals 8a through 8f and the fixed side terminals 14a through 14f, namely, they are

arranged in a circle. Accordingly, the circle formed by ends of the elastic bodies 7a through 7f on the fixed side substrate 13 is smaller in size than the one formed by the ends of the elastic bodies 7a through 7f on the movable side substrate 6. As seen from FIGS. 8 and 9, the linear elastic bodies 7a through 8f are thereby conically shaped, by which the second preferred embodiment is characteristically distinct from the first preferred embodiment where the elastic bodies 7a through 7f are cylindrically shaped. In addition to the operation for supporting the lens holder 2 on the support member 10, the linear elastic bodies 7a through 7f are also operable to supply current to the focusing coil 3, to the tilting coil 4, and to the tracking coil 5. The movable side terminals 8a through 8f are therefore connected to the focusing coil 3, to the tilting coil 4, and to the tracking coil 5 by electric wires.

[0048] Next, the operations of the device for driving optical system according to the second preferred embodiment will be discussed. The device of the second preferred embodiment is also controlled by moving coil system as in the first preferred embodiment. Therefore, control operations for focusing, tracking and tilting are basically the same as in the first preferred embodiment. Besides, as the linear elastic bodies 7a through 7f are conically shaped in the second preferred embodiment, the amount of interference in the movements in the focusing direction Fo and in tracking direction Tk to be caused by tilting control can be reduced to a greater degree. This is because the amount of interference resulting from tilting control varies in the length direction of the linear elastic bodies 7a through 7f. Therefore, the conically-shaped elastic bodies 7a through 7f produce movements in the focusing direction Fo and in the tracking direction Tk that are relatively smaller than those produced by the cylindrically-shaped elastic bodies 7a through 7f.

[0049] In the second preferred embodiment, the lens holder 2 is supported on the support member 10 by the six linear elastic bodies 7a through 7f. However, the number of the linear elastic body may not be limited to this. As long as the linear elastic body is arranged in the same manner as that in the second preferred embodiment, the same effect can be obtained.

[0050] <Third Preferred Embodiment>

[0051] FIG. 12 is a perspective view illustrating a device for driving optical system according to the third preferred embodiment of the present invention. Only a lens holder of the device is illustrated in each perspective view of FIGS. 13 and 14. The structure of the lens holder 2 is the same as that in the first preferred embodiment. The objective lens 1 for focusing light on an optical recording medium (not shown) and irradiating the same with the focused light is held on the lens holder 2. The lens holder 2 has the focusing coil 3, the tilting coil 4, and the tracking coil 5 provided on three surfaces thereof adjacent to the surface for holding the objective lens 1. Further, the lens holder 2 has the movable side substrate 6 on the surface thereof opposite to that for holding the tracking coil 5. Still further, in contrast to the lens holder 2 in the first preferred embodiment, the lens holder 2 in the third preferred embodiment is a rectangular parallelepiped having a small thickness in the focusing direction Fo.

[0052] FIG. 15 is a plan view illustrating the movable side substrate. The movable side substrate 6 is a rectangle having a short side in the focusing direction Fo. The six movable side terminals 8a through 8f are provided on the movable side substrate 6 for fixing the ends of the six linear elastic bodies 7a through 7f, respectively. These movable side terminals 8a through 8f are arranged in a circle. A center of this circle is an axis of point symmetry of the movable side terminals 8a through 8f. Further, distances between the movable side terminals

8a through 8f adjacent to each other in the focusing direction Fo are shorter than those between the terminals 8a through 8f adjacent to each other in a direction perpendicular to the focusing direction Fo. For example, the distance between the movable side terminals 8a and 8b is shorter than the distance between the movable side terminals 8a and 8d.

[0053] The structure of the base member 9 as a foundation of the device is the same as that in the first preferred embodiment. More particularly, the base member 9 holds the support member 10 provided thereon for supporting the lens holder 2. Further provided on the base member 9 are the permanent magnet 11 for focusing and tilting control, and the permanent magnet 12 for tracking control. Further, the fixed side substrate 13 is provided on the surface of the support member 10 for supporting the lens holder 2. To comply with the shape of the lens holder 2, the support member 10 and the permanent magnet 11, for example, are each rectangular parallelepiped having a small thickness in the focusing direction Fo.

[0054] FIG. 16 is a plan view illustrating the fixed side substrate. To comply with the shape of the movable side substrate 6, the fixed side substrate 13 is also a rectangle as well having a short side in the focusing direction Fo. The six fixed side terminals 14a through 14f are provided on the fixed side substrate 13 for further fixing the ends of the six linear elastic bodies 7a through 7f, respectively. These fixed side terminals 14a through 14f are also arranged in a circle. A center of this circle is an axis of point symmetry of the fixed side terminals 14a through 14f. Further, distances between the fixed side terminals 14a through 14f adjacent to each other in the focusing direction Fo are shorter than those between the terminals 14a through 14 adjacent to each other in a direction perpendicular to the focusing direction Fo. For example, the distance between the fixed side terminals 14c and 14d is shorter than the distance between the terminals 14c and 14b. The movable side terminals 8a through 8f and the fixed side terminals 14a through 14f are symmetrically arranged in mirror image, respectively. Further, the circle formed by the movable side terminals 8a through 8f and that formed by the fixed side terminals 14a through 14f are approximately the same in size.

[0055] Similar to the first preferred embodiment, the movable side substrate 6 and the fixed side substrate 13 are also connected by the six linear elastic bodies 7a through 7f having the same length, to support the lens holder 2 on the support member 10. The ends of the linear elastic bodies 7a through 7f are arranged in the same manner as those of the movable side terminals 8a through 8f and the fixed side terminals 14a through 14f, namely, they are arranged in a circle. A center of the circle formed by the ends of the elastic bodies 7a through 7f is an axis of point symmetry thereof. Further, distances between the ends of the elastic bodies 7a through 7f adjacent to each other in the focusing direction Fo are shorter than those between the ends thereof adjacent to each other in a direction perpendicular to the focusing direction Fo. Accordingly, in the device of the third preferred embodiment, the linear elastic bodies 7a through 7f are cylindrically shaped. In addition to the operation for supporting the lens holder 2 on the support member 10, the linear elastic bodies 7a through 7f are also operable to supply current to the focusing coil 3, to the tilting coil 4, and to the tracking coil 5. The movable side terminals 8a through 8f are therefore connected to the focusing coil 3, to the tilting coil 4, and to the tracking coil 5 by electric wires.

[0056] According to the foregoing configuration, while being operative in the same manner as that in the first preferred embodiment, shrinkage is allowed in the focusing direction Fo in the device of the third preferred embodiment as compared with the device of the first preferred

embodiment. As a result, reduction in thickness of a device is also allowed that includes the device of the third preferred embodiment incorporated therein. The operations of the device for driving optical system of the third preferred embodiment are the same as those of the device according to the first preferred embodiment and therefore, the description thereof is omitted.

[0057] In the third preferred embodiment, the lens holder 2 is supported on the support member 10 by the six linear elastic bodies 7a through 7f. However, the number of the linear elastic body may not be limited to this. As long as the linear elastic body is arranged in the same manner as that in the third preferred embodiment, the same effect can be obtained.

[0058] While the invention has been shown and described in detail, the foregoing description is in all aspects illustrative and not restrictive. It is therefore understood that numerous modifications and variations can be devised without departing from the scope of the invention.

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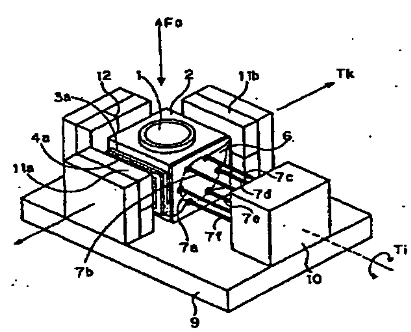
[54] 发明名称 光学机构驱动装置

[57] 摘要

本发明提供一种光学机构驱动装置，仅用至少 6 根线状弹性体支持镜座，并且能够进行调焦方向 Fo、跟踪方向 Tk、倾斜方向 Ti 的 3 轴驱动。为使光聚焦照射在光学记录介质(未图示)上的物镜(1)被保持在镜座(2)上。另一方面，在成为光学机构驱动装置的底座的基台(9)上设有支持镜座(2)用的支持台(10)。本发明的光学机构驱动装置是将 6 根相同长度的线状弹性体(7a～7f)呈圆筒状配置从而将镜座(2)支持于支持台(10)上的构造。由此线状弹性体(7a～7f)的端部形成的圆的中心是线状弹性体(7a～7f)的端部的点对称轴。还有，相邻线状弹性体(7a～7f)的端部间的距离配置成完全一致。



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1. 一种光学机构驱动装置，配备有：使光聚焦照射在光学记录介质上的光学机构；保持上述光学机构的底座；支持上述底座的支持体；由长度相同的至少 6 根线状弹性体构成，将上述线状弹性体的一端呈大致圆形地配置并固定于支持体上，将上述线状弹性体的另一端呈大致圆形地配置并固定于上述底座上的使上述底座支持于上述支持体上的支持机构；使上述底座在上述光学机构的光轴方向上驱动的调焦驱动装置；使上述底座在上述光学记录介质的半径方向上驱动的跟踪驱动装置；使上述底座以垂直于上述光轴方向及上述光学记录介质的半径方向的方向为轴，绕上述轴转动的方向驱动的倾斜驱动装置。

2. 根据权利要求 1 所记载的光学机构驱动装置，上述支持机构的上述支持体一侧及上述底座一侧的上述线状弹性体的端部具有点对称轴。

3. 根据权利要求 1 所记载的光学机构驱动装置，上述支持机构的上述支持体一侧及上述底座一侧的相邻的上述线状弹性体的端部间的距离完全相同。

4. 根据权利要求 1 至权利要求 3 中的任一项所记载的光学机构驱动装置，上述支持机构的上述支持体一侧的线状弹性体的端部形成的圆的大小和上述底座一侧的上述线状弹性体的端部形成的圆的大小大致相同。

5. 根据权利要求 1 至权利要求 3 中的任一项所记载的光学机构驱动装置，上述支持机构的上述支持体一侧的上述线状弹性体的端部形成的圆的大小和上述底座一侧的上述线状弹性体的端部形成的圆的大小不同。

6. 根据权利要求 1 或权利要求 2 所记载的光学机构驱动装置，上述支持机构的上述支持体一侧和上述底座一侧的上述光轴方向上相邻的上述线状弹性体的端部间的距离比与垂直于上述光轴方向的方向上相邻的上述线状弹性体的端部间的距离短。

7. 根据权利要求 1 至权利要求 3 中的任一项所记载的光学机构驱动装置，上述支持机构，至少 6 根线状弹性体由同一材料制成。

一侧的线状弹性体的端部形成的圆的大小和底座一侧的线状弹性体的端部形成的圆的大小大致相同。

本发明的技术方案 5 的解决方式，其特征是：支持机构的支持体一侧的线状弹性体的端部形成的圆的大小和底座一侧的线状弹性体的端部形成的圆的大小不同。

本发明的技术方案 6 的解决方式，其特征是：支持机构的支持体一侧和底座一侧的光轴方向的相邻的线状弹性体的端部间的距离比垂直于光轴方向的方向上相邻的线状弹性体的端部间的距离短。

本发明的技术方案 7 的解决方式，其特征是：支持机构，至少 6 根线状弹性体由同一材料制成。

本发明的技术方案 1 记载的光学机构驱动装置，将长度相同的至少 6 根线状弹性体的端部呈大致圆形配置并固定在支持体及底座上，从而用线状弹性体将底座支持于支持体上，故不仅可以进行 3 轴驱动而且有降低零件成本、减少组装工时的效果。而且，有抑制组装偏差、减少装置的性能波动的效果。

本发明的技术方案 2 记载的光学机构驱动装置，由于支持体和底座一侧的线状弹性体的端部具有点对称轴，故具有能够降低倾斜驱动对调焦驱动和跟踪驱动的动作带来干扰的效果。

本发明的技术方案 3 记载的光学机构驱动装置，由于支持体和底座一侧的相邻的线状弹性体的端部之间的距离完全相同，故具有不产生非对称的反作用力，从而能够稳定地倾斜驱动的效果。

本发明的技术方案 4 记载的光学机构驱动装置，由于线状弹性体的两端部形成的圆的大小大致相同，故具有不仅能够进行 3 轴驱动而且可以降低零件成本、减少组装工时的效果。

本发明的技术方案 5 记载的光学机构驱动装置，由于支持体一侧的线状弹性体的端部形成的圆的大小和底座一侧的的端部形成的圆的大小不同，故具有能够使调焦驱动和跟踪驱动更加稳定地进行的效果。

本发明的技术方案 6 记载的光学机构驱动装置，由于支持体和底座一侧的光轴方向上相邻的线状弹性体的端部间的距离比垂直于光轴方向的方向上相邻的端部间的距离短，故具有能够减薄光学机构驱动装置在光轴方向上的厚度的效果。

本发明的技术方案7记载的光学机构驱动装置，由于至少6根线状弹性体用同一材料制成，故具有能够稳定进行调焦方向、跟踪方向、倾斜方向的3轴驱动的效果。

图面说明

图1是表示本发明实施方式1的光学机构驱动装置的轴测图。

图2是表示本发明实施方式1的镜座部分的轴测图。

图3是表示本发明实施方式1的镜座部分的轴测图。

图4是表示本发明实施方式1的可动部一侧基板的俯视图。

图5是表示本发明实施方式1的固定部一侧基板的俯视图。

图6是表示受本发明实施方式1的倾斜控制的可动部一侧端子的运动的概念图。

图7是表示本发明实施方式2的光学机构驱动装置的轴测图。

图8是表示本发明实施方式2的镜座部分的轴测图。

图9是表示本发明实施方式2的镜座部分的轴测图。

图10是表示本发明实施方式2的可动部一侧基板的俯视图。

图11是表示本发明实施方式2的固定部一侧基板的俯视图。

图12是表示本发明实施方式3的光学机构驱动装置的轴测图。

图13是表示本发明实施方式3的镜座部分的轴测图。

图14是表示本发明实施方式3的镜座部分的轴测图。

图15是表示本发明实施方式3的可动部一侧基板的俯视图。

图16是表示本发明实施方式3的固定部一侧基板的俯视图。

图17是表示以往的光学机构驱动装置的轴测图。

图18是表示受以往的光学机构驱动装置的倾斜控制的镜座的运动的截面图。

具体实施方式

实施方式1

图1所示为本实施方式的光学机构驱动装置的轴测图。图2和图3所表示仅为镜座部分的轴测图。为使光聚焦照射在光学记录介质（未图示）上的物镜1被保持在镜座2上。此镜座2在与固定物镜1的面相邻的三个面上有调焦用线圈3、倾斜用线圈4及跟踪用线圈5。调焦用线圈3由2个缠绕方向相同的线圈3a、3b（图4所示）构成，平行地安装在镜座2的面上。还有，倾斜用线圈4由2个缠绕方向不同的

线圈 4a、4b 构成，重叠在调焦用线圈 3 上平行地安装。跟踪用线圈 5 安装在上述三个面中的剩下的一面上。而且，镜座 2 在和跟踪用线圈 5 平行的面上备有可动部一侧基板 6。

图 4 所示为可动部一侧基板的俯视图。在可动部一侧基板 6 上，设有为固定 6 根线状弹性体 7a－7f 的端部的 6 个可动部一侧端子 8a－8f。此可动部一侧端子 8a－8f 呈圆形配置。而且，此圆的中心成为可动部一侧端子 8a～8f 的点对称轴。还有，在可动部一侧基板 6 上相邻的可动部一侧端子 8a～8f 之间的距离配置成完全一致。例如，可动部一侧端子 8a 和可动部一侧端子 8b 的距离与可动部一侧端子 8b 和可动部一侧端子 8c 的距离相同。

另一方面，在成为光学机构驱动装置的底座的基台 9 上设有为支持镜座 2 的支持台 10。因此，基台 9 和支持台 10 成为镜座 2 的支持体（以下相同）。还有，在此基台 9 上，设有调焦和倾斜控制用永久磁铁 11 和跟踪控制用永久磁铁 12。此调焦和倾斜控制用永久磁铁 11 由 2 块永久磁铁 11a、11b 构成，相互对面地设于基台 9 上的位置上。而且，调焦和倾斜控制用永久磁铁 11a、11b 由在上下方向被极化的 2 极磁化构成。跟踪控制用永久磁铁 12 设于与基台 9 上的支持台 10 对面的位置上。而且跟踪控制用永久磁铁 12 由在左右方向被极化的 2 极磁化构成。再者，基台 9 一般多用磁性体等金属制成。而且，在支持台 10 的支持镜座 2 的面上设有固定部一侧基板 13。

图 5 所示为固定部一侧基板的俯视图。在固定部一侧基板 13 上也设有为固定 6 根线状弹性体 7a～7f 的端部的 6 个固定部一侧端子 14a～14f。此固定部一侧端子 14a～14f 也呈圆形配置。而且，此圆的中心成为固定部一侧端子 14a－14f 的点对称轴。又，在固定部一侧基板 13 上相邻的固定部一侧端子 14a～14f 之间的距离配置成完全一致。在此，可动部一侧端子 8a～8f 和固定部一侧端子 14a～14f 配置在镜面对称的位置上。而且，可动部一侧端子 8a～8f 形成的圆的大小和固定部一侧端子 14a～14f 形成的圆的大小大致相同。

接下来，在本实施方式的光学机构驱动装置上，将镜座 2 配置在被支持台 10、调焦和倾斜控制用永久磁铁 11a、11b 及跟踪控制用永久磁铁 12 包围的位置上，且用 6 根相同长度的线状弹性体 7a～7f 支持在支持台 10 上。此时，调焦用线圈 3 和倾斜用线圈 4 与调焦和倾斜

控制用永久磁铁 11a、11b 相向配置，跟踪用线圈 5 与跟踪控制用永久磁铁 12 相向配置。

线状弹性体 7a～7f 是连接可动部一侧端子 8a～8f 和固定部一侧端子 14a～14f 的部件。而且，6 根线状弹性体 7a～7f 由同一材料制成。线状弹性体 7a～7f 的端部按照可动部一侧端子 8a～8f 和固定部一侧端子 14a～14f 的配置而配置成圆形。而且，由线状弹性体 7a～7f 的端部形成的圆的中心成为线状弹性体 7a～7f 的端部的点对称轴。还有，相邻的线状弹性体 7a～7f 的端部之间的距离配置成完全一致。因此，如图 2 及图 3 所示，本实施方式的光学机构驱动装置中，线状弹性体 7a～7f 为呈圆筒状配置的构造。再者，线状弹性体 7a～7f 除了将镜座 2 支持于支持台 10 上之外，还向调焦用线圈 3、倾斜用线圈 4 及跟踪用线圈 5 供给电流。因此，可动部一侧端子 8a～8f 用电线接于调焦用线圈 3、倾斜用线圈 4 及跟踪用线圈 5 上。

下面，就本实施方式的光学机构驱动装置的动作做说明。在图 1 中，将使光聚焦照射在光学记录介质（未图示）上的光轴方向作为调焦方向 Fo（上下方向）的轴，将光学记录介质的半径方向作为跟踪方向 Tk（左右方向）的轴，将与调焦方向 Fo 及跟踪方向 Tk 垂直的方向作为轴，将围绕此轴转动的方向作为倾斜方向 Ti。

本实施方式的光学机构驱动装置用动圈方式控制，即，光学机构驱动装置通过向安装于镜座 2 的各种线圈供给电流，控制和设于基台 9 上的各种永久磁铁之间产生的磁力，从而控制镜座 2 的位置。然后，物镜 1 有必要使光聚焦于光学记录介质（未图示）上，但是，由于光学记录介质的表面振动等上下运动引起焦点错动。因此，光学机构驱动装置用周知的象散法等聚焦传感器（未图示）检测错动的焦点检出，将与其焦点错动的量相应的信号通电至调焦线圈 3。由此，光学机构驱动装置使镜座 2 在调焦方向 Fo 上移动，进行调焦控制。

而且，物镜 1 为了读出由光学记录介质（未图示）上的位串构成的信息，必须将聚焦的光照射在此位串上。但是，物镜 1 往往会由于光学记录介质的偏心而引起磁道错动的情况。因此，光学机构驱动装置用周知的差动推拉法等的跟踪传感器（未图示）检测磁道错动，并将与其磁道错动量相应的信号通电至跟踪用线圈 5。由此，光学机构驱动装置使镜座 2 在跟踪方向 Tk 上移动而进行跟踪控制。在进行这些调

直于调焦方向 Fo 的方向上相邻的固定部一侧端子 14a－14f 之间的距离短。例如，从固定部一侧端子 14c 到固定部一侧端子 14d 的距离比从固定部一侧端子 14c 到固定部一侧端子 14b 的距离短。在这里，可动部一侧端子 8a～8f 和固定部一侧端子 14a～14f 配置在镜面对称的位置上。而且，固定部一侧端子 14a～14f 形成的圆的大小与可动部一侧端子 8a－8f 形成的圆的大小大致相同。

接下来，本实施方式与实施方式 1 相同，通过将可动部一侧基板 6 和固定部一侧基板 13 用 6 根相同长度的线状弹性体 7a～7f 连接起来，从而将镜座 2 支持于支持台 10 上。线状弹性体 7a～7f 的端部按照可动部一侧端子 8a～8f 和固定部一侧端子 14a－14f 的配置而配置成圆形。而且，由线状弹性体 7a－7f 的端部形成的圆的中心成为线状弹性体 7a－7f 的端部的点对称轴。而且，在调焦方向 Fo 上相邻的线状弹性体 7a～7f 的端部间的距离比在垂直于调焦方向 Fo 的方向上相邻的固定线状弹性体 7a－7f 的端部间的距离短。因此，在本实施方式的光学机构驱动装置中，线状弹性体 7a～7f 为配置成圆筒状的构造。再者，线状弹性体 7a－7f 除了将镜座 2 支持于支持台 10 上之外，还向调焦用线圈 3、倾斜用线圈 4 及跟踪用线圈 5 供给电流。因此，可动部一侧端子 8a－8f 用电线连接于调焦用线圈 3、倾斜用线圈 4 及跟踪用线圈 5 上。

根据本实施方式的构造，既具有和在实施方式 1 中所示的光学机构驱动装置同样的功能，又能够将光学机构驱动装置的调焦方向 Fo 的尺寸设得比实施方式 1 的薄。因此，能够将组装该光学机构驱动装置的装置也设得薄一些。还有，本实施方式的光学机构驱动装置的动作由于与实施方式 1 相同故省略其说明。

还有，在本实施方式中，将镜座 2 用 6 根线状弹性体 7a～7f 支持于支持台 10 上。但是，线状弹性体的数量即使是 6 根以外，只要象本实施方式那样配置也可以得到同样的效果。

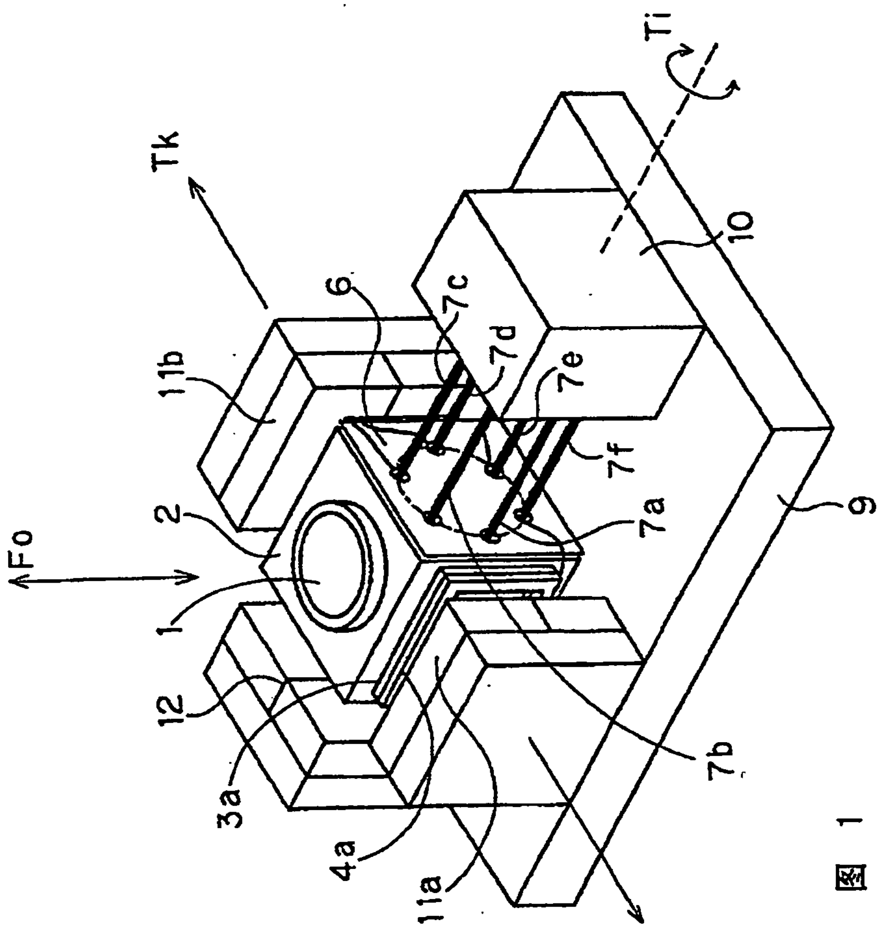

图 1

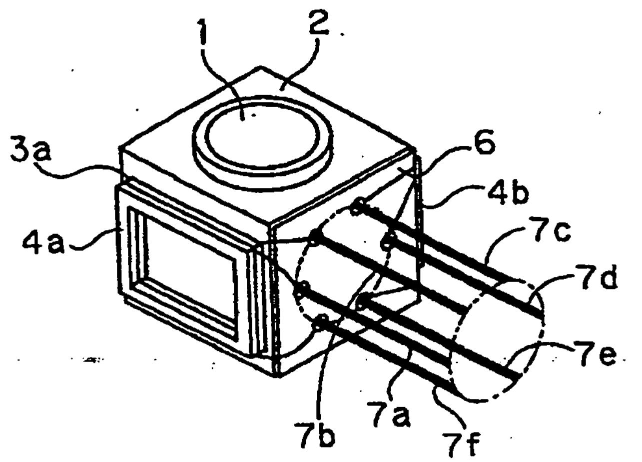
1
2
3a
6
4b
4a
7c
7d
7e
7b
7a
7f

图 2

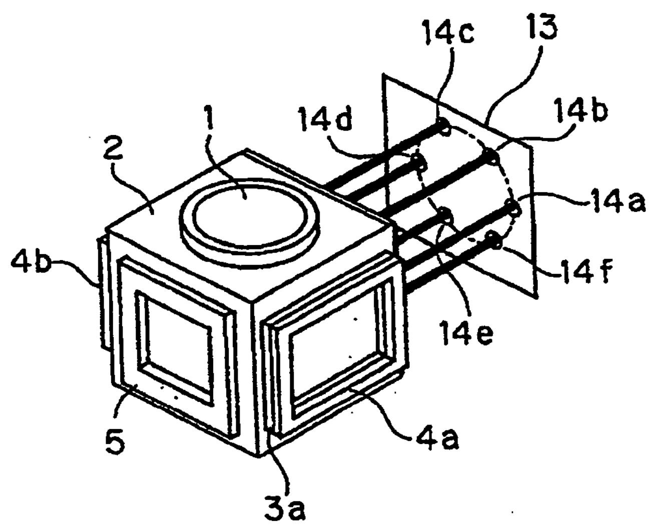
14c
13
14d
1
14b
2
14a
4b
14f
14e
5
4a
3a

图 3

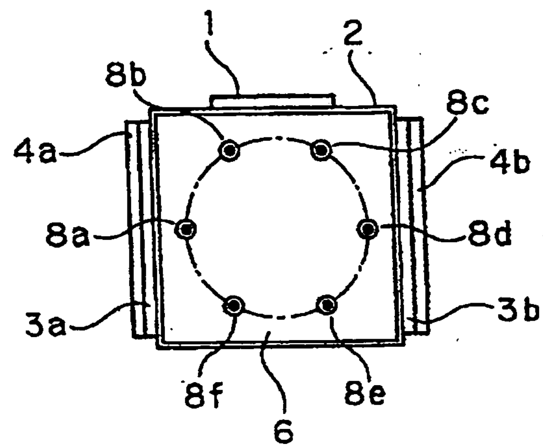

图 4

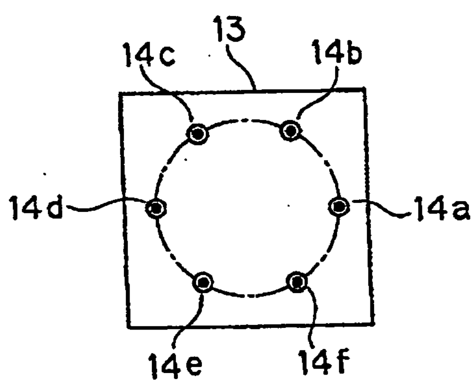

图 5